HC–98A/98B/108/108A/108B/108C Series – Master Keysheet (w/Non Link–Belt Carriers)

(1H or 9LBH, 9LDH, 9LFH, 9LGH, 9LJR, 9LNH Prefix On Crane Serial Number)

AREA 00 GENERAL INFORMATION

****

SM00–000–000.00 Service Manual General Usage & Instructions

AREA 03 UPPER REVOLVING FRAME

****

SM03–001–031.00 Undecking Machine
SM03–004–005.00 Conical Rollers
SM03–005–002.00 Gear Case Lube System
SM03–006–002.00 Swing Lock Control
SM03–007–002.00 Low Gantry Assembly
SM03–008–002.00 Retractable Gantry
SM03–009–001.00 Hydraulic Retractable Gantry
SM03–010–015.00 Hydraulic Counterweight Removal

AREA 04 VERTICAL SHAFTS

****

SM04–000–007.00 Vertical Shafts (General)
SM04–002–009.00 Center Drive Shaft
SM04–003–015.00 Swing Shaft
SM04–004–003.00 Swing Brake Shaft
SM04–005–011.00 Swing Brake

AREA 05 HORIZONTAL SHAFTS

****

SM05–000–008.00 Horizontal Shafts (General)
SM05–001–003.00 Independent Swing/Reverse Shaft
SM05–002–005.00 Reduction Shaft
SM05–003–003.00 Front Drum Shaft
SM05–003–005.00 Front & Rear Drum Brakes
SM05–004–001.00 Rear Drum Shaft
SM05–004–002.00 Auxiliary Rear Drum Brake
SM05–005–001.00 Third Drum Shaft
SM05–005–002.00 Third Drum Brake
SM05–006–002.00 Two Speed Drums
SM05–007–001.00 Two Speed Planetary
SM05–007–002.00 Planetary Brakes
SM05–008–002.00 Boom Hoist Shaft
SM05–008–003.00 Boom Hoist Brake
SM05–009–002.00 Clutches – General
SM05–009–004.00 Clutch Assemblies
SM05–009–005.00 Third Drum Clutch
SM05–009–009.00 Clutch Rotating Joint

AREA 06 UPPER ENGINE

****

SM06–022–003.00 GMC Engine Wiring
SM06–024–017.00 Cummins Wiring – Standard Cab
SM06–024–018.00 Cummins Wiring – Elevated Cab
SM06–024–019.00 Cat Wiring – Standard Cab
SM06–024–020.00 Cat Wiring – Elevated Cab
SM06–039–007.00 Chain Case

AREA 07 HYDRAULIC POWER SUPPLY

****

SM07−000−005.00 S−o−M System − General
SM07−000−006.00 S−o−M Troubleshooting
SM07−001−001.00 Unloading Valve
SM07−001−002.00 Accumulator
SM07−001−004.00 External Clutch Valve
SM07−001−005.00 Relief Valve
SM07−001−008.00 S−o−M Filter
SM07−001−011.00 Relief Valve
SM07−003−006.00 Solenoid Valves, General Recondition
SM07−005−006.00 S−o−M Pomp
SM07−012−002.00 Control Stand
SM07−018−001.00 Hydraulic System Tube Fittings

AREA 08 ANGLE BOOM & JIB

****

SM08−001−001.00 Repairing Damaged Angle Booms & Jibs

AREA 09 TUBULAR BOOM, FLY, & JIB

****

SM09−001−002.00 Repairing Damaged Tubular Booms, Flys, & Jibs
SM09−002−004.00 Hydraulic Boom Live Mast

AREA 10 TAGLINE WINDER

****

SM10−001−001.00 Tagline Winder
SM10−001−002.00 Tag & Magnet Reel

AREA 18 SPECIAL ATTACHMENTS

****

SM18−000−001.00 Capscrew Torques
SM18−000−002.00 Bearing, Gear, Shaft, & Housing Inspection

How To Use This Manual, General Service Instructions, And Safety Procedures

The following information is provided to help guide the user of this manual. An explanation of how this manual is organized, as well as general information and safety considerations which should be understood when performing any service or maintenance procedure, is given. This information is general in nature and should supplement any of the specific procedures in this manual along with a constant awareness of safety and common sense.

How To Use This Manual

This Service Manual is a collection of written procedures which are used to service and maintain a specific crane model. The index, which is called a "Keysheet", is used to organize the procedures within this manual and serve as a Table Of Contents as well. Each procedure, in this manual, is written so that it can stand alone and typically covers only one procedure. Procedures are given a numerical designation, or "SM Code" Number, (Example: SM01—005—034.00) which is unique to that procedure and that procedure only. The following is a listing of the general area definitions which are designated by the first digits in the SM Code Number sequence:

General Area Descriptions

SM01 — Rubber Tire Lower
SM02 — Crawler Lower
SM03 — Upper Revolving Frame & Machinery
SM04 — Vertical Shafts
SM05 — Horizontal Shafts
SM06 — Upper Engine
SM07 — Hydraulic Power Supply
SM08 — Angle Boom
SM09 — Tubular Boom
SM10 — Tagline Winder
SM11 — Fairleader
SM12 — Shovel Attachment
SM13 — Trench Hoe, Logger & Scrapper Attachment & Prop Handler
SM14 — Cab & House Assembly
SM15 — Rotascope Attachment (Discontinued)
SM16 — Wire Rope Requirements
SM17 — Hydraulic Boom And Attachments
SM18 — Special Attachments
SM19 — Diesel Pile Hammer (Discontinued)
SM20 — Tower, Climbing Assembly, Traveling Base & Gantry (Discontinued)
SM21 — Log Skidder (Discontinued)
SM22 — Hydraulic Hammer (Discontinued)

The procedures in this manual are collated by SM Code Number sequence. Use the Keysheet in the front of this manual, the general area descriptions shown previously, and the SM Code title shown on the Keysheet to find the specific procedure required to service the crane.

Throughout this manual, reference is made to the left, right, front, and rear, pertaining to directions and locations. These reference directions are relative to the operator, sitting in the operator's seat, with the upper directly over the front of the carrier, unless otherwise stated. (Crawler mounted cranes: upper over the front of the crane with travel motors to the rear.)

Danger, warning, and caution captions as well as special notes are used throughout this manual and on the crane to emphasize important and critical instructions. **If any instruction, caution, warning, or danger labels, decals, or plates become lost, damaged, or unreadable, they must be replaced.** Information contained on such labels, decals, and plates is important and failure to follow the information they contain could result in an accident. Replacement labels, decals, and plates can be ordered through a Link-Belt Distributor. For the purpose of this manual, danger, warning, and caution captions and notes are defined as follows:

DANGER

An operating procedure, practice, etc. which, if not correctly followed, may result in severe personal injury, dismemberment, or loss of life.

WARNING

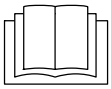
An operating procedure, practice, etc. which, if not correctly followed, may result in personal injury.

CAUTION

An operating procedure, practice, etc. which, if not correctly followed, may result in damage to, or destruction of, equipment or property.

NOTES

Note: An operating procedure step, condition, etc. which is essential in order for the process to be completed properly.



This symbol may appear in manuals or on a label on the crane to alert personnel that additional instructions are included in the crane Operator's Manual.

Figure 1
Keep hands and tools clear of moving parts.

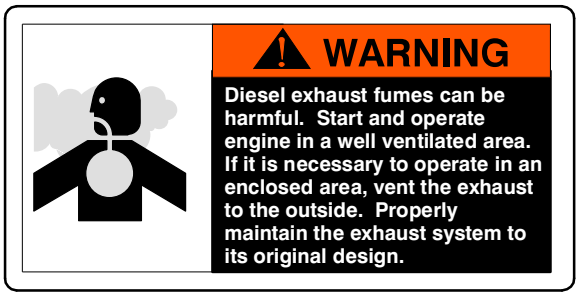

WARNING
Diesel exhaust fumes can be harmful. Start and operate engine in a well ventilated area. If it is necessary to operate in an enclosed area, vent the exhaust to the outside. Properly maintain the exhaust system to its original design.

Figure 2
Diesel Exhaust Fumes.

Service Safety And Set Up Guidelines

The following is a list of safety and set up considerations which may apply to any service or maintenance procedure. Review the entire list and understand the type of things you must consider to perform a safe service procedure and then apply these guidelines to each specific service or maintenance procedure.

DANGER

Do not operate the crane unless you are qualified. Unauthorized operation by untrained personnel could result in an accident. Crane operation is to be performed by a certified operator only.

Service Safety

1. Read and understand the service or maintenance procedure to be performed before beginning work. By reading the procedure ahead of time, you can be sure to have the replacement parts and tools on hand that are required to complete the job.
2. Wear protective gear to prevent injury; hard hat, safety glasses, gloves, steel toed shoes, etc.

Figure 3
Pinch Point Label

3. First aid supplies and a fire extinguisher should be on the job site to assist in an unexpected situation. The location of these items should be known to all as well as access to a telephone for emergencies.
4. Work in a clean, dry, firm, level area whenever possible. Choosing the correct work site can make a big difference on how well the job goes.
5. Use caution around flammable materials. Be aware of all the materials in the work area which are a threat. Also make others aware of volatile materials; post signs if necessary.
6. Release all trapped pressure in air and hydraulic circuits before disconnecting any line or component. Shutdown the crane, exhaust all pressure from the crane's air reservoir(s) and work the hydraulic control levers back and forth before servicing the crane.
7. Do not disconnect any hydraulic line from a crane which has its attachment in the air. Trapped pressure may be all that is suspending it. Disconnecting a line could release the trapped pressure, causing the attachment to fall. Lower the attachment to the ground or on to its rest before servicing the crane.
8. Do not work on a crane which is in motion. Fans, belts, gear trains, etc. can catch an unexpecting person and quickly dismember them.
9. Do not climb on the attachment or other hard to reach areas. If the steps and/or ladders which are installed on the crane do not provide adequate access to the area of the crane which needs servicing, use a step ladder or other approved device.
10. Pinch points exists between the upper and lower frames. Death or dismemberment may result from personnel caught in these points. Learn where these pinch points are and stay clear of the rotating upper frame.

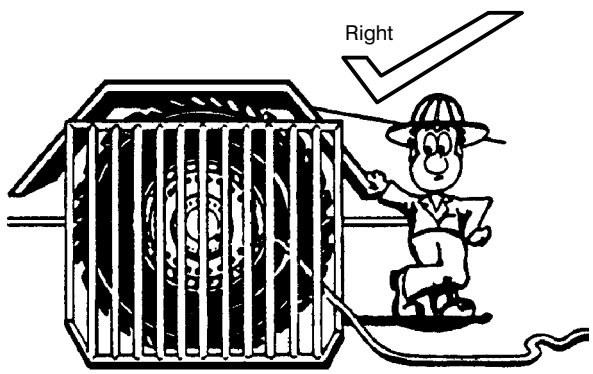


Figure 4
Use a guard when inflating tires.

11. If working in a confined area, be sure to provide adequate ventilation when running the engine(s), using toxic solvents, welding, or any other operation which contaminates the fresh air supply.
12. Post a sign in the operator's cab to alert others that the crane is under service. Starting the crane while it is being serviced could severely injure someone. Crane damage could also occur if systems are operated prematurely. Imagine starting the engine(s) before the oil is replaced.
13. Secure access panels, doors, and machinery hoods when in the open position to ensure they do not fall or slam shut due to wind or accidental disruption.
14. Crane parts may be heavy. Always use an appropriate lifting device to support work. Do not attempt to lift an object without knowing its weight. Get help if necessary.
15. Always use a safety rim cage when inflating or deflating tires. Worn or misassembled parts can "explode" from the assembly causing serious injury. Use a safety rim cage, clip on air chuck, and stand aside when inflating or deflating tires.

Crane Set Up And Disassembly

1. Properly park the crane as described in the Operator's Manual. Park the crane in an area which provides the most comfortable working conditions. However, do not park the crane where it will be an obstruction or an intrusion to traffic, coworkers, or to the public. Keep in mind that a major service procedure, or a repair part which requires a long lead time, could have the crane disabled for an extended period of time.
2. Keep in mind the mess which is sometimes caused by a crane under repair. Oil or other fluid leaks should be contained or prevented. Consider your responsibility of maintaining a safe clean work area and a healthy environment for all.

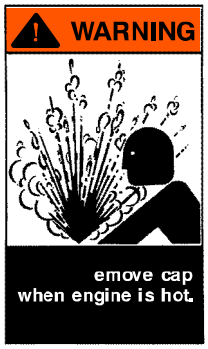


Figure 5
Allow engine to cool before removing the radiator cap.

3. If the crane is equipped with outriggers, it may be safer as well as an advantage to raise and level the crane on outriggers to provide easier access to areas underneath. Do not work under a crane that is improperly supported.
4. Shutdown the engine(s) per the instructions given in the Operator's Manual.
5. Post a sign in the operator's cab to alert others that the crane is being serviced.
6. Engines, transmissions, hydraulic systems, etc. generate extreme heat during operation. Temperatures can reach levels which may cause serious burns. Allow the crane to cool before attempting to service it.

WARNING

Engine coolant is hot. Failure to allow engine(s) to sufficiently cool before draining coolant could result in severe burns or other personal injury. Allow the engine(s) and radiator(s) to cool before draining coolant from the radiator(s).

7. Pressure is generated inside the engine's cooling system due to the heat transfer process from the engine(s) to the radiator(s). Do not attempt to open or drain the radiator(s) until it/they has/have had sufficient time to cool. Disconnecting hoses before the engine(s) and radiator(s) has/have cooled is even more dangerous. Wait until the engine(s) and radiator(s) have cooled and then drain the radiator(s) before disconnecting any hoses. Properly store or dispose of used coolant.

THIS IS A SAMPLE
MANUAL
FOR THE COMPLETE
MANUAL

CLICK HERE TO DOWNLOAD

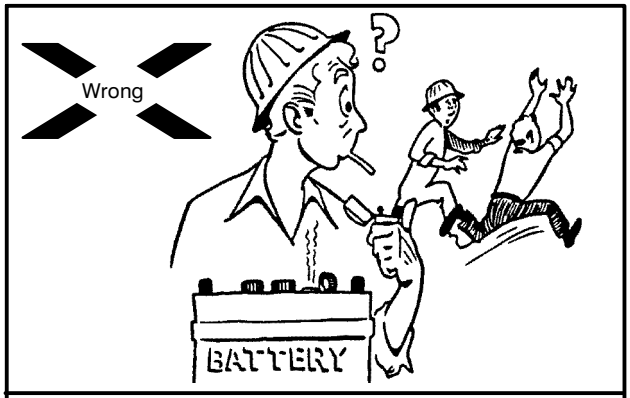


Figure 6
Do not use an open flame near the battery.

WARNING

Solvents and cleaning solutions can be hazardous. Serious personal injury may result from misuse of these products. Read and follow all the manufacturer's recommendations concerning solvents and cleaning solutions.

8. Thoroughly clean the area of the crane which is to be serviced. Dirt or other contamination could enter the hydraulic, air, lubricating system, etc. and cause immediate and/or long term problems. Cleaning the service area not only prevents contamination problems but it also makes working on the crane easier and sometimes problems are more recognizable.
9. Before beginning any removal or disassembly procedure, take a moment to observe critical features of the assembly which may greatly simplify the installation or assembly process. Label electrical, hydraulic, air, or other connections. Index mark pump, motor, and valve sections. Lightly spray paint or count the threads of adjustment screws. Simple steps such as these can minimize the effort needed to put the crane back in service.

WARNING

Hydraulic oil is under pressure and may be hot. A sudden release of hot oil could cause severe burns and/or other serious injury. Shutdown the engine(s) and exhaust all trapped hydraulic pressure from the system before removing any line or component.

10. Hydraulic systems, while operating, are under high pressure. Even after the crane is shutdown these pressures can remain trapped in the hydraulic lines and system components. Some hydraulic systems utilize an air pressurized reservoir which maintains pressure on the system after the crane is shutdown. It is critical that all residual pressure, which is trapped in the system, be neutralized before disconnecting any line or hydraulic component. Use the following techniques to exhaust trapped hydraulic pressure from the system:
    a. Lower the attachment to the boom rest, onto blocking, or onto the ground and shutdown the engine(s).
    b. Open the drain valves on the air system reservoir(s), if equipped, to bleed the air system pressure.
    c. Relieve any residual or precharge pressure by pushing the button on the pressure relief valve, on the hydraulic reservoir, if equipped. Otherwise, loosen the filler cap 1/4 turn.
    d. Turn the ignition switch to the **ON POSITION**, but **DO NOT START THE ENGINE.**
    e. Operate the steering control(s) back and forth repeatedly until steering becomes hard. (On cranes equipped with emergency steering system, it will take several rotations of steering wheel before steering becomes hard.)
    f. Work the crane control levers and outrigger switches, if equipped, back and forth several times.
    g. Turn ignition switch to the **OFF POSITION.**
    h. When pressure is fully relieved, close the drain valves on the air system reservoir(s), if equipped.

WARNING

Air lines may contain high pressure. Opening lines and fittings before relieving air pressure may result in serious injury. Shutdown the engine(s) and drain the air system reservoir(s) before opening any line or fitting.

11. Air system circuits, like hydraulic circuits, contain high pressures also. Although the threat of a hot working fluid does not exist, highly pressurized lines and components can possibly "fly off" if lines are disconnected before the system pressure is relieved. Open the drain valve on the air system reservoir(s) to exhaust system pressure before working on the crane.

WARNING

Use care not to cause sparks at the battery terminals while disconnecting or connecting the battery. Battery gasses are volatile and could be ignited by a spark or flame causing the battery to explode. Keep the area around the battery well ventilated and disconnect the negative side of the battery first, with the ignition switch "OFF", to minimize hazard.

Battery posts, terminals, and related accessories contain lead and lead compounds. Eating or smoking with lead residue on hands may cause lead poisoning. Wash hands after handling lead products.

12. When working on electrical circuits, disconnect the battery to minimize shock, burn, spark, or other hazard. When disconnecting the battery, confirm that the ignition switch is in the "OFF" position. Disconnect the negative side of the battery first to minimize the potential for sparks at the battery. Battery gases which are exposed to such sparks, could cause an explosion. Likewise when connecting the battery, confirm that the ignition switch is in the "OFF" position and install the positive cable(s), first and the negative connection(s) last.
13. It is a good practice when disassembling hydraulic components to lay the parts out in the order that they were disassembled. Keeping the parts in this order during disassembly, cleaning, and inspection will aid in the assembly process.

Welding

1. When making repairs which require welding, disconnect any electronic equipment (such as rated capacity limiters and engine computers) to prevent damage to them. Use the battery disconnect switch(es), if equipped.
2. Be aware of systems adjacent to areas being welded. Residual heat from the welding process could cause damage to other components. Heat may also vaporize materials which may become toxic or volatile.
3. Remove paint from areas to be welded to prevent toxic fumes.
4. The grounding connection should be within 3 feet (*1 m*) of the welded parts.
5. Connect the ground to the lower, if welding on the lower, or to the upper if welding on the upper. Electrical current through the turntable bearing could cause an arc which could damage it.
6. Do not position the ground connection where seals or bearing, as in transmissions or valves, will be between it and the welded parts.
7. Remove any flammable materials from the area.
8. Use the appropriate setting on the welder for the size of the welding operation. Do not use more than 200 Volts continuously.

Cleaning And Inspection

WARNING

Solvents and cleaning solutions can be hazardous. Serious personal injury may result from misuse of these products. Read and follow all the manufacturer's recommendations concerning solvents and cleaning solutions.

1. All components should be thoroughly cleaned with an approved cleaning solvent, air dried and carefully inspected for damage, wear and corrosion.
2. All Loctite® or other sealant residue should be removed from threads of hardware and parts that are going to be reused.
3. All "soft parts", such as seals, gaskets, back up rings, and o-rings, should be replaced.
4. Replacement of bearings and bushings is generally a good preventive maintenance measure. Even though a bearing or bushing seems to be intact and is functioning properly, its life span is limited. Replacing a simple bearing or bushing while the opportunity is at hand could save a complete component failure later.
5. In the event of severe defects, contact factory personnel for directions whether to repair or replace any major component.

Crane Assembly

1. Loosely assemble parts to ensure all parts are in place and fasteners started before beginning torquing procedure. Always use a cross torquing sequence to ensure even and uniform installation.

WARNING

Lubricants, sealants, joint and thread locking compounds, etc. can be hazardous. Serious personal injury may result from misuse of these products. Read and follow all manufacturer's recommendations concerning these products.

Figure 7
Proper disposal is important.

2. Unless otherwise stated, torque all fasteners per the instructions given in SM Code Area 18—000.
3. When installing hydraulic hoses, lines, and fittings, use two wrenches to ensure the hoses and lines are not twisted. One wrench must be on the male fitting, the other wrench on the female fitting.
4. Unless otherwise stated, torque all hydraulic fittings per the instructions given in SM Code Area 07—018.
5. Check all fluid levels before returning the crane to service; hydraulic reservoir oil level, transmission fluid level, engine(s) oil level, etc. Add oil as required. See Operator's Manual and/or engine(s) manufacturer's manual(s) for correct type of fluids and procedures.
6. Always replace guards, grilles, and other types of protective shields. Also, be sure that any systems which were disconnected such as load indicating systems, anti-two block devices, control cables, etc. are functioning properly before returning the crane to service.
7. Start the appropriate engine and let it idle for five minutes. Inspect the connections on the hydraulic, air, transmission, etc. lines for leaks. Repair if needed.
8. Check that all hydraulic, air, and electrical functions are operating normally before returning the crane to service.
9. After crane is assembled, refer to the Operator's Manual for any periodic type of adjustments which may have been affected by the service procedure.
10. Properly dispose of any used oils, solvents, cleaners, etc.

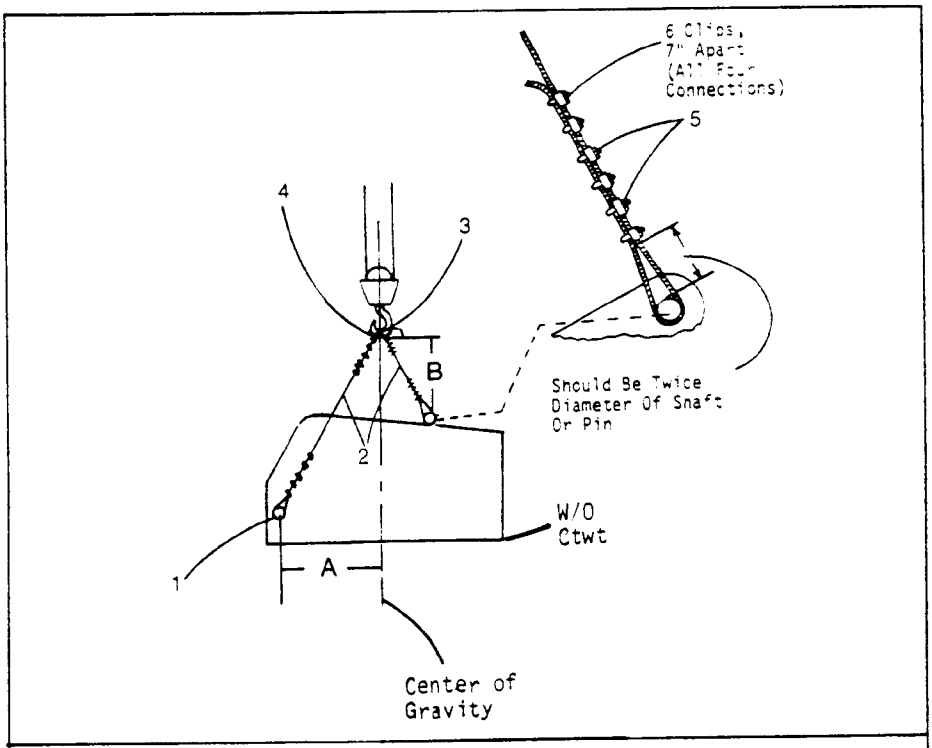


Fig. 1
Sling Arrangement
(A) 5.97' (1.82m)
(1) Boom Foot Pins
(2) Sling
(3) Hook Block
(B) 5' (1.52m) Above Shaft
(4) Thimble
(5) Wire Rope Clips - 6 Per Connection, 7" (17.8cm) Apart.

Note: Center Of Gravity Will Vary Due To Weights Of Optional Equipment.

General

The basic upper weighs about 20,000 lbs (9072 kg) without boom, ctwt., and catwalks. Addition of optional equipment will increase this weight. The following are examples of optional weights:

F.D. Lowering	400 lbs (181.4 kg)
R.D. Lowering	500 lbs (227 kg)
3rd Drum	50 lbs (386 kg)
Planetaries (each)	450 lbs (204 kg)
High Gantry	1450 lbs (658 kg)
Ind. Swing And Travel	1320 lbs (599 kg)
Optional Torque Converter	690 lbs (313 kg)

An upper with several options could weigh as much as 26,000 lbs (11794 kg) lifting equipment must be supplied which can safely lift the upper. This equipment must be in good condition, properly adjusted and reeved, before attempting to lift the upper. Refer to the lifting equipments capacity chart and make sure it can do the job before proceeding.

Preparation For Undecking The Machine: Refer to Operator's Manual, and remove the following:
(a) Remove jib or tip extension from the boom. Remove boom from machine.
(b) Remove catwalks from the machine if so equipped.
(c) Remove all counterweight from the machine.
(d) Remove live mast if so equipped.
(e) Remove boom backstops.
(f) Lower the retractable gantry.

Refer to shop manual, and remove the following:
(a) Remove all conical rollers.
(b) Remove the rotating joint.

Undecking Machine
(a) Attach slings to upper. Connect one leg to each boom foot pin, and one leg to each end of the extended gantry headshaft. (Where backstops connect.) Install keeper pins or cotter pins in the boom foot pins to prevent their working out.

Secure the rear slings to the headshaft with tie wire to prevent the slings coming off the shaft.

The sling must have four legs and be strong enough to lift the upper. If using wire rope, use a minimum 1" diameter rope with a minimum breaking strength of at least 51 tons. FMC type N rope is recommended. Use new rope straight off the reel for making up the sling. Never use used, scrapped, or damaged rope for a sling as an accident may occur. Refer to Fig. 1 for more information. See Section 8 in Operator's Manual for information on installation of wire rope clips. Use 6 clips, 7" apart at all connections.
(b) Connect hook block from lifting equipment to the slings. Hoist against slings to provide some tension in the sling.
(c) Lift the upper slightly to check balance. If necessary, set it down and readjust the slings.
(d) Lift the upper off of its mounting. Stay out from under the upper while lifting.
(e) Set the upper on blocking to prevent damage to S-o-M tubing or control linkages under the upper.

Roller Path Replacement: Refer to General Bulletin number 167 for information on replacement of the roller path. This may be obtained from your FMC distributor.

Center Pin Bushing Replacement:
(a) Remove the set screws which prevent the bushing turning in its housing.
(b) Use a puller to remove the old bushing.
(c) Install the new bushing
(d) Drill two holes in the crack between the O.D. of the bushing and the I.D. of the housing.
(e) Tap the holes. Install a socket head set screw in each hole to keep the bushing from rotating.

Decking The Machine:
(a) Install sling assemblies on the machine. See Fig. 1, and steps a, b, c, under undecking procedure.
(b) Lift upper and position over lower. Make sure coupling is in place on vertical travel shaft.
(c) Lower the upper into place on its mounting.
(d) Install and adjust conical rollers. See SM3-4-5.0.
(e) Install rotating joint. See

SM1-48-5.0, or 2-10-5.0.
(f) Refer to Section 2 in Operator's Manual. Lubricate center pin bushing.
(g) Remove slings.
(h) Refer to Operator's Manual. Install ctwt., mast, backstops, attachment, etc.

WARNING

Stay Out From Under Suspended Upper. Don't Get Between Upper And Mounting. If The Upper Should Shift Suddenly, Or Fall, You May Be Injured.

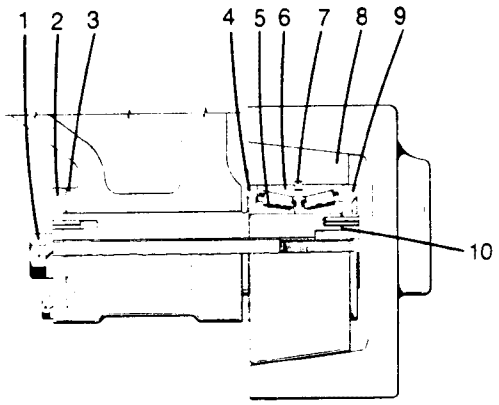


Fig. 1 296-C
Single Conical Roller Assembly

(1) Bolt
(2) End Cap
(3) Shims
(4) Retainer
(5) Cone
(6) Cup
(7) Snap Ring
(8) Roller
(9) Retainer
(10) Shims

CONICAL ROLLERS: The weight of the upper frame is supported on the roller path by the conical rollers. As the upper swings with respect to the lower, the conical rollers roll around between the flanges of the roller path. Because of the hook type roller construction used with this machine, they also serve the purpose of connecting the upper to the lower. Each roller is mounted on two tapered roller bearings.

CONICAL ROLLER REMOVAL: The conical rollers may be removed for inspection or repair as follows:

(a) Balance the weight of the upper with jacks and blocking, to remove any load against the conical rollers.
(b) Remove the capscrews from the shaft end cap.
(c) Remove the center bolt. This will expose a set of threads in the roller shaft. These threads are for installing a pulling attachment.
(d) Pull the roller shaft from the housing.
(e) Remove the roller from the machine.

Removal of Bearing Cups: If necessary, the roller bearings may be removed from the conical rollers. They are a press fit, and should be removed with a bearing puller.

Reassembly of Conical Rollers: If new bearings are to be installed, and a press is available, use the following procedure:

(a) Clean all parts thoroughly.
(b) Insert two snap rings in the grooves within the roller.
(c) Rub molykote powder on the outside diameter of the bearing cup, and the inside diameter of the conical roller.
(d) Insert one bearing cup, heavy side first, and press in place until it is about flush with the roller face.
(e) Invert roller and place first cup on plug. Insert second bearing cup, heavy side first. Place second plug on top, and press until both bearings are seated against the ring. Apply at least 10,000 pounds pressure to seat the bearings properly. If a press is not available, operations (d) and (e) may be done by driving both cups in approximately 3/4", taking care not to cock them as they enter the roller. Make two steel plugs, 4-15/16" outer diameter by 7/8" thick, with 1-1/16" hole in the middle. Put one plug on each side of the roller, and run a 1" diameter bolt through the assembly. Put on the nut, lubricate the threads, and tighten the nut until a final torque of at least 200 ft/lb. is reached.
(f) Assemble the shaft, roller, two retainer bolts and the center bolt, in a vise. The bearings in the conical roller must be pre-loaded between 10 and 12 ft/lb., when the center bolt is torqued to 400 ft/lb. The pre-load is changed by adding or subtracting shims between the roller cap and the shaft. The following shims are available for this adjustment:
(1) 1B793 - - - - - - .005"
(2) 1B794 - - - - - - .007"
(3) 1B795 - - - - - - .020"
The center bolt must be tightened to 400 ft/lb. before the pre-load is checked. The pre-load may be determined by clamping a bar to the conical roller, and measuring the force necessary to rotate it with a "fish scale". Multiply the scale reading times the distance from the center of the roller to the scale hook in feet to obtain the pre-load.
(g) Disassemble the shaft and roller, and reassemble on the machine. Rotate the roller while tightening the center bolt to 400 ft/lb. to make sure it works free. Reinstall the same shims that were removed under the end cap. Install the capscrews, tighten them down, and install the lockwire.

CONICAL ROLLER ADJUSTMENT: The conical rollers may be adjusted to compensate for wear to the roller, and the roller path. On a hook roller machine, the loading is

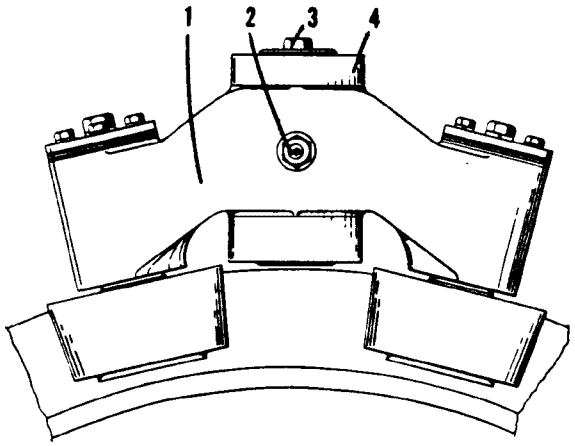


Fig. 2 A297-B
Equalizer Beam Assembly

(1) Equalizer Beam
(2) Set Screw/Jam Nut
(3) Puller Hole
(4) Mounting Bracket

supposed to be taken on the flanges of the roller path. Clearance between the conical rollers and the flange must be kept to a minimum, to prevent excessive loadings on the center pin and bushing. The recommended clearance is from 1/32" to a maximum of 1/8". This clearance is obtained at the point of least wear on the roller path. This adjustment may be made as follows:

(a) Loosen the three capscrews which hold the end cap on the shaft. Do not disturb the center bolt as this will change the bearing pre-load.
(b) Remove the required number of shims, to move the roller farther into the roller path flange, thereby decreasing the clearance. The following shims are used in this location:
    (1) 1B151 . . . . . 1/8"
    (2) 1B316 . . . . . 16 ga.
(c) Install capscrews, tighten, and rewire.

EQUALIZER BEAMS: Equalizer beams are used with six and eight conical rollers. They are used on the front of the LS98 and front and rear of LS108B and LS118 machines. The assembly consists of two roller assemblies, mounted in a beam which is free to pivot, equalizing loadings on the two rollers.

EQUALIZER BEAM REMOVAL: The equalizer beam may be removed from the machine in the following manner.

(a) Remove the conical rollers as explained earlier in this section.
(b) Remove the jam nut and set screw which locks the beam in place.
(c) Remove the bolt in the end of the equalizer shaft. This will expose a threaded hole for installation of a puller.
(d) Pull the shaft from the bracket. Reassemble by following the above procedure in reverse. Be sure the set screw enters the hole in the equalizer shaft. Replace the capscrew in the puller hole to protect the threads.

EQUALIZER BEAM REASSEMBLY:

(a) Rub molykote powder, or NeverSeize on the shaft so it won't freeze in place.
(b) Place the equalizer beam in the mounting bracket.
(c) Install the equalizer shaft, making sure the lock hole in the shaft lines up with the threaded hole in the equalizer beam.
(d) Install and tighten the set screw. Install and tighten a jam nut on the set screw.
(e) Install a capscrew in the puller hole to protect the threads.
(f) Install the conical rollers as explained previously in this SM.

ROLLER MOUNTING BRACKETS: The conical roller bracket bolts should be inspected after a few days operation on a new machine. Tighten the bolts to 2000 ft/lb. torque.

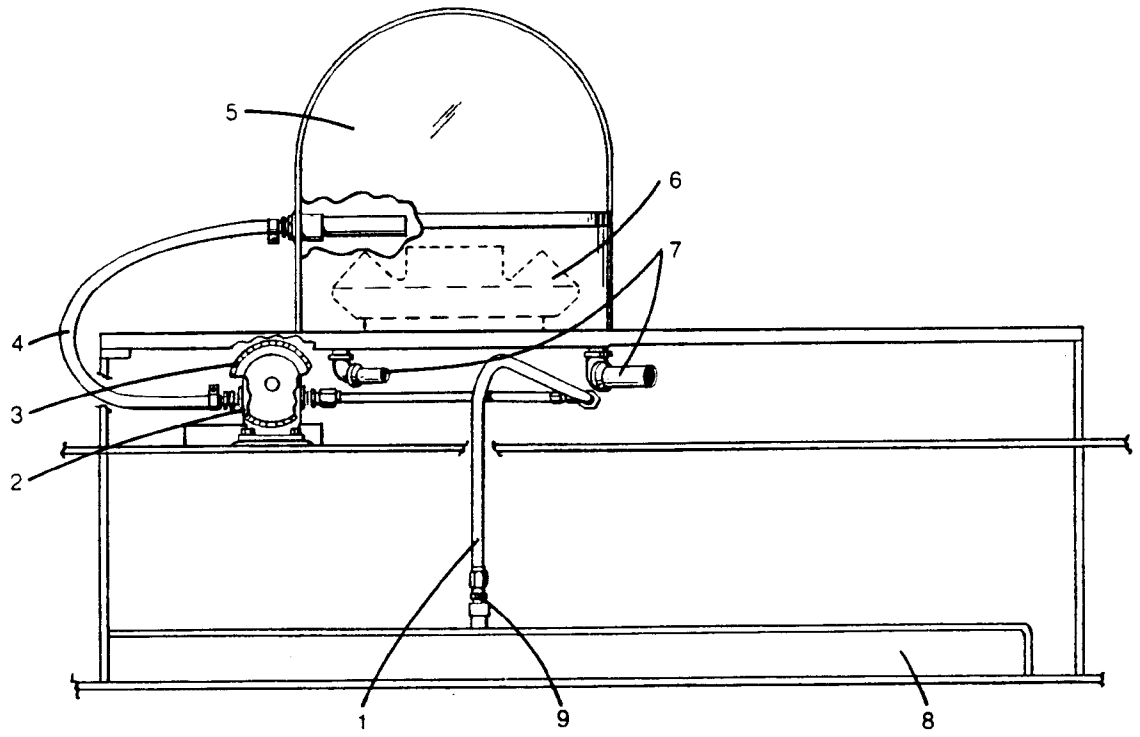


Fig. 1 A239-B
Gear Case Lubrication System

(1) Suction Line
(2) Pump
(3) Pump Pinion
(4) Flow Indicator Line
(5) Bevel Gear Case
(6) Bevel Gear Drain
(7) Bevel Gear Drains
(8) Horizontal Gear Case
(9) Sump
(10) Oil Pick-Up

System Operation (Fig. 1)

The reverse shaft bevel gear and the horizontal deck gears run in oil supplied by the gear case lubrication system. The oil is circulated through the system by a Browne And Sharpe gear type pump (item 2 in Fig. 1). The pump is driven by the reverse shaft gear on the right side of the machine. Refer to Fig. 1.

The oil is pumped from the sump (9) up the suction line (1) and into the reverse bevel gear case (5). After the oil flows around and through the bevel gear (6), the oil passes through two outlet pipes (7). The outlet pipes empty into the horizontal gear case (8). After the oil lubricates the horizontal gears, it drains back to the sump (9).

Note: On machines with independent swing, the gear case lubricating system does not lubricate the bevel gears on the horizontal swing shaft and the vertical swing center drive shaft. These components are located in a separate compartment that is not connected to the gear case lubricating system. Check the lubrication chart for the capacity and change interval of this compartment.

System Maintenance

Oil Level Check (Fig. 1)

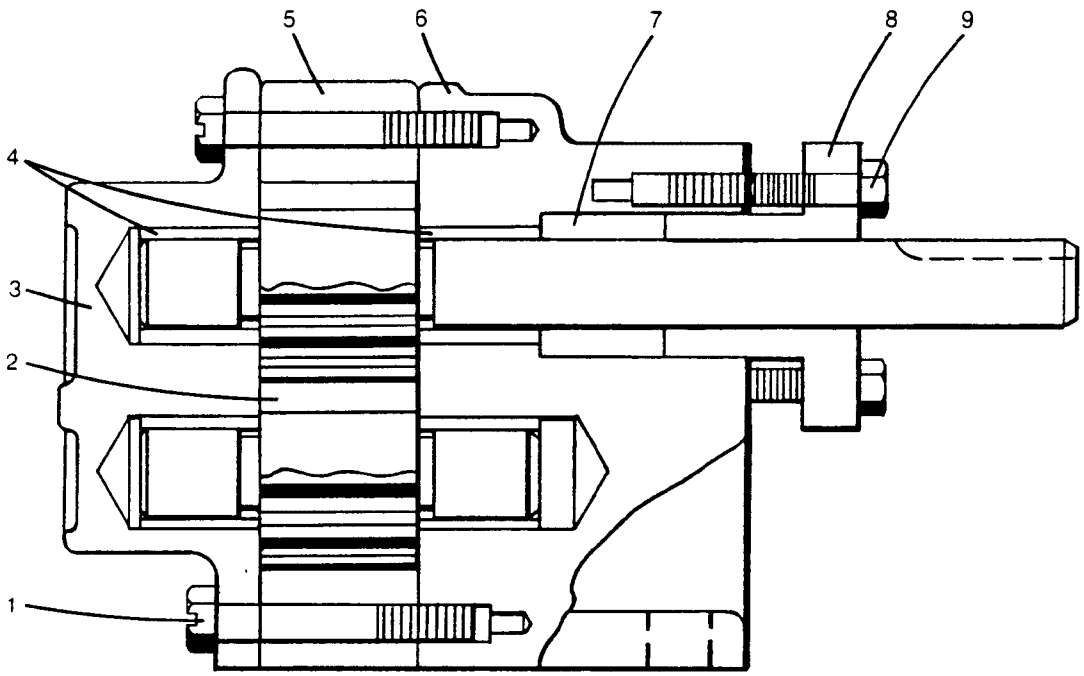
To check the oil level, the system is equipped with a flow indicator. Two types of flow indicators are used, either a sight glass or a transparent flow indicator line (item 4 in Fig. 1), depending on the date of manufacture.

When the gear train is rotating, the flow indicator will be full of oil. When the master clutch is disengaged and the gear train stops, the oil level in the indicator will drop. After the gear train has stopped for a few minutes, the indicator will be empty.

An empty indicator, with the gear train stopped, is normal for this system. If the indicator does not fill with oil when the gear train is turning, troubleshoot the system. Check the oil level and for plugged lines. If the problem is not here, check the output of the pump. Refer to the "Pump Repair" section of this SM for more information.

Oil Change (Fig. 1)

To drain the sump (item 9 in Fig. 1), remove a drain plug located to the rear of the bottom plate. The filler plug is located on the left hand side of the machine. Refer to the lubrication chart or Operator's Manual for the lubricant and change interval.



ig. 2 A271-A
ear Case Lubrication Pump

1) Stand Screws
2) Matched Gear Set
3) Cap
(4) Gear Bushings
(5) Gear Housing
(6) Stand
(7) Packing
(8) Gland
(9) Gland Screws

ote: The bevel gear (6) has a /8" (9.5mm) hole drilled in it or lubrication purposes. Every ime you open the bevel gear case 5), inspect this hole to make ure it is not plugged. If this ole is plugged, open the hole p. If the hole remains plugged, he oil will not lubricate the ertical center shaft drive bear- ng.

ump Repair

ump Performance

he pump delivers 3 gallons 11.37 L) of oil per minute at igh engine idle. At full load peed, the pump delivers 2.5 gal- ons (9.46 L) of oil per minute. f pump output is below these igures, first check the system il level. Next, inspect the ystem lines to make sure they re not plugged, finally, if you etermine the pump is faulty, do he following:

Pump Disassembly (Figs. 1 and 2)

(a) Disconnect the lubrication lines from the pump. Cap all the lines to keep dirt out of the lubricating system. Remove the pump mounting hardware and take the pump off the machine. Refer to Fig. 1.
(b) Drain all oil from the pump. Remove the pinion (3 in Fig.1) from the pump shaft. Clamp the pump in a vise equipped with soft metal guards, such as lead or copper, to protect the pump.

Note: Never clamp the pump in a vise unless the jaws are protected by a soft metal such as lead or copper.

(c) Remove the gland screws (9 in Fig. 2) from the pump. Remove the gland (8) from the pump.
(d) Remove the stand screws (1) from the pump. Remove the cap and bushings (3) from the pump. Also remove the gear housing (5).
(e) Remove the matched gear set (2) from the pump.
(f) Remove the packing (7) from the pump.

Pump Inspection

(a) Inspect the bushings (4) in the cap (3) and the stand (6). Also inspect the gear housing (5). Replace all defective parts.
(b) Inspect the matched gear set (2). Check for worn, chipped, or missing teeth. Also check the shaft splines for wear or damage. If one of the gears is defective, you must install a new set of replacement gears. Finally, if the condition of any part is questionable, replace the part.
(c) Inspect the gland (8) for wear or damage. Replace if necessary.

Pump Reassembly (Figs. 1 and 2)

(a) If necessary, install new bushings (4 in Fig. 2) in the cap (3) and stand (6).
(b) Install new packing (7) in the stand (6). Refer to Fig. 2.
(c) Clamp the stand (6) in a vise equipped with soft metal guards, such as copper or lead, to protect the stand.

Note: Never clamp the stand in a vise unless the jaws are protected by a soft metal such as lead or copper.

(d) Install the gear set (2) in the stand (6). Refer to Fig. 2.
(e) Apply Permatex #2 or equivalent to the mating surfaces of the stand (6) and the gear housing (5). Also apply the Permatex #2 to the mating surfaces of the cap (3) and the gear housing (5).
(f) Install the gear housing (5) and cap (3) on the stand. Secure with stand screws (1). Refer to Fig. 2.
(g) Install the gland (8) on the back of the stand (6). Secure the gland with the gland screws (9). Avoid cramping the gland or installing it too tightly to prevent shaft seizure and pump failure. Slight leakage is recommended to lubricate the packing (7). Refer to Fig. 2.
(h) Install the pump pinion (3 in Fig. 1) on the pump shaft. Install the key and set screws to secure the pinion. Next install the pump (2) on the machine. Check the pump pinion for precise alignment. Secure with capscrews.
(i) Inspect the fittings on both the suction line (1) and flow indicator line (4). Remove any burrs and clean up all dirt. Spread a small amount of pipe compound on the male fittings. If you apply too much compound, the excess compound will squirt inside the pump when you connect the line. Next, connect the suction and flow indicator lines (1 and 4) to the pump. Make sure the connections don't put a strain on the pump. Refer to Fig. 1.
(j) Disconnect the flow indicator line (4) from the bevel gear case (5). Insert a funnel in the end of the line and pour a small amount of the gear lubricant down into the pump. After the pump is primed, remove the funnel and reconnect the line to the bevel gear case.

Pump Maintenance (Fig. 2)

Periodically the gland (8) must be adjusted. The gland seal is a compression type and requires occasional adjustment. Allow a small amount of leakage to lubricate the packing. Be careful not to overtighten the seal. If you do, the shaft will seize and the pump will fail.